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A Dynamic Cutting Forces Model of Vibrations Assisted Drilling

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ABSTRACT

The increasing part of composite materials in aeronautic multi-materials structures highlights the need to develop adapted new manufacturing processes for assembly. The MITIS company offers a solution of Vibrations Assisted Drilling in order to improve reliability of drilling operations on multi-layer materials. Forced vibrations are added to conventional motions to create a discontinuous cutting. The back and forth movement allows to improve the evacuation of chips by breaking it. This technology introduces two new operating parameters, the oscillation frequency and the amplitude. To optimize the process, the choice of parameters requires first to model precisely the operation cutting and dynamics. Indeed, the dynamical behavior of the whole machining system can affect the cutting dynamics and thus modify the chip breaking condition. In this paper, a kinematic modeling of the process is firstly proposed. A cutting force model of vibrations assisted drilling is then proposed. The limits of the modeling are analyzed through comparison between measured and simulated down-hole surfaces. From experimental tests results, the model is then completed in order to take into account dynamic phenomena that may explain behavior differences between tests and simulations. The proposed model of cutting forces considering the dynamical behavior of the machining system allows foreseeing the operating conditions which ensure good chips breaking and tool life. This work also presents the experimental method and the test results to validate the numerical simulator.